

Rediscovery of the New Guinea Big-eared Bat *Pharotis imogene* from Central Province, Papua New Guinea

CATHERINE HUGHES¹*, JULIE BROKEN-BROW¹, HARRY PARNABY²,
STEVE HAMILTON³, AND LUKE K.-P. LEUNG¹

¹ School of Agriculture & Food Sciences, University of Queensland, Gatton Queensland 4343, Australia

² Australian Museum, 6 College Street, Sydney New South Wales 2010, Australia

³ PO Box 22, Dodges Ferry Tasmania 7173, Australia

catherine.hughes@uqconnect.edu.au

ABSTRACT. The New Guinea Big-eared Bat *Pharotis imogene* has not been reported since the first and only specimens were collected in 1890 and the species was presumed extinct. We document the capture of one individual of the species from the coastal district of Abau, in Central Province, Papua New Guinea, 120 km east of the only previous known locality at Kamali. We recommend that field surveys be urgently undertaken to assess the conservation status of the species.

KEYWORDS: *Pharotis*; Chiroptera; Vespertilionidae; bat conservation; endemic species; New Guinea

HUGHES, CATHERINE, JULIE BROKEN-BROW, HARRY PARNABY, STEVE HAMILTON, AND LUKE K.-P. LEUNG. 2014. Rediscovery of the New Guinea Big-eared Bat *Pharotis imogene* from Central Province, Papua New Guinea. *Records of the Australian Museum* 66(4): 225–232, <http://dx.doi.org/10.3853/j.2201-4349.66.2014.1632>

The diverse bat fauna of Papua New Guinea includes ten genera and 34 species of pteropods (“fruit bats”, Pteropidae) and an assemblage of 25 genera and 57 echolocating species (Bonaccorso, 1998). Of these 35 bat genera, the endemic, monotypic genus *Pharotis* is one of the most poorly known. The New Guinea Big-eared Bat *Pharotis imogene* Thomas, 1914 and the long-eared bats (also called big-eared bats) of the genus *Nyctophilus*, are distinguished from all other Papua New Guinea genera of the family Vespertilionidae by a combination of large ears and a simple nose-leaf immediately posterior to the nostrils (Bonaccorso, 1998). The phylogenetic relationships of *Pharotis* and *Nyctophilus*

to each other and to remaining genera of Vespertilionidae remains unclear. Both genera have been placed either in their own subfamily Nyctophilinae (e.g., by Hill & Harrison, 1987) or in the subfamily Vespertilioninae, sometimes as a distinct tribe nyctophilini or in the tribe vespertilionini (see Roehrs *et al.*, 2010).

The largest of the four species of *Nyctophilus* known from Papua New Guinea is distinguished by body size (Flannery, 1995). Previously known as the Greater Long-eared Bat *N. timoriensis* (Geoffroy, 1806), it is now recognized as a distinct endemic New Guinea species *N. shirleyi* Parnaby, 2009. The Small-eared Nyctophilus *N. microtis* Thomas,

* author for correspondence

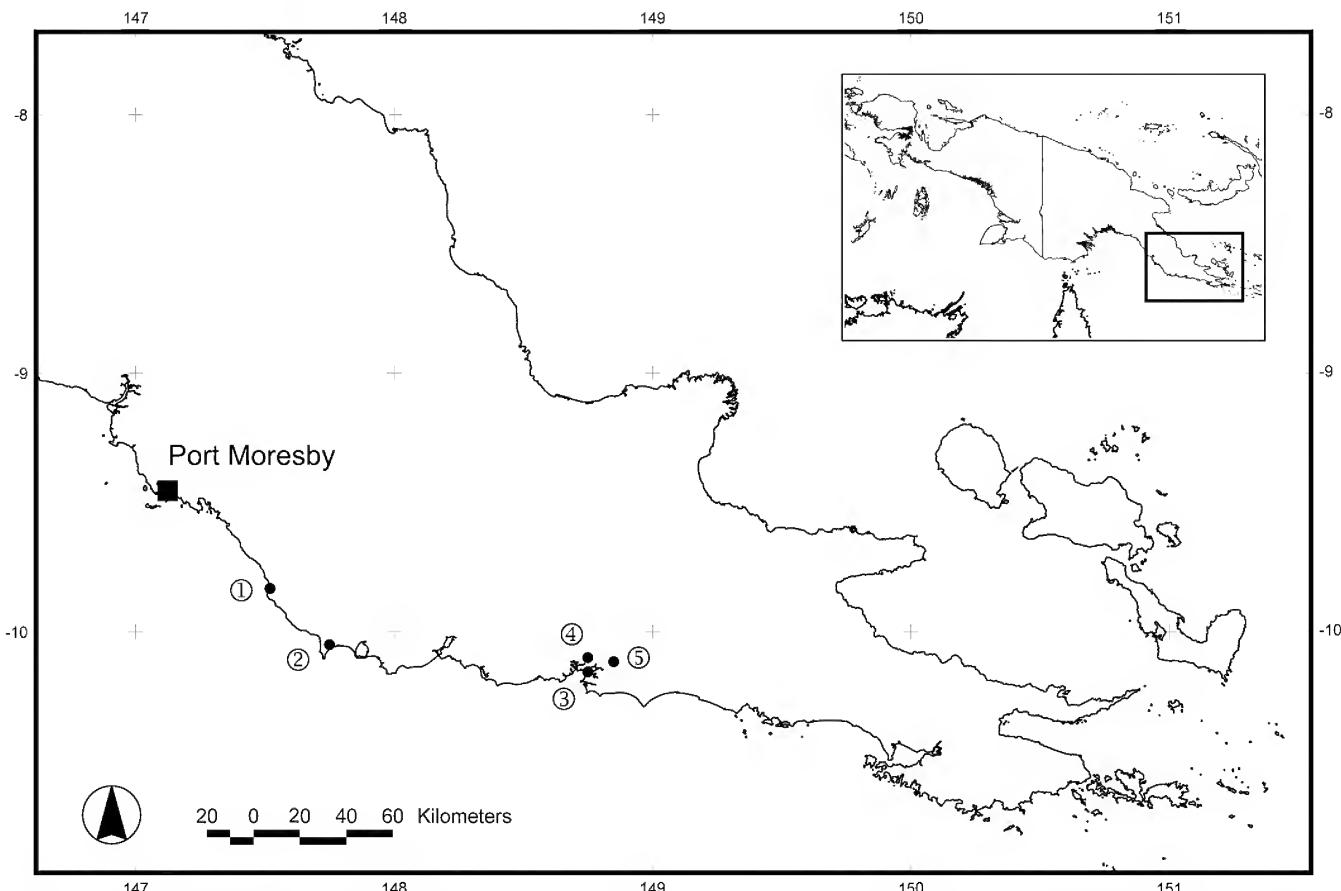


Figure 1. Map indicating localities in the Central Province, Papua New Guinea, mentioned in the text: (1) Kapa Kapa; (2) Kamali; (3) Abau; (4) Bonoabo and (5) Oio village. Bam village (not shown) is c. 2 km north of Oio.

1888 is the most widely distributed and smallest species, differentiated by its relatively small ears which, unlike other Papua New Guinean species of the genus, are not joined above the forehead by a skin membrane (Bonaccorso, 1998). The Northern Long-eared Bat *N. bifax* Thomas, 1915 resembles a smaller version of *N. shirleyi* in external appearance (Parnaby, 2009). It has an extensive Australian distribution but is known from few records from Papua New Guinea (Bonaccorso, 1998). The Small-toothed Nyctophilus *N. microdon* Laurie and Hill, 1954 is endemic to Papua New Guinea (Bonaccorso, 1998). It is distinguished from other Papua New Guinean *Nyctophilus* by its relatively large ears and tragus and in both of these features it resembles *Pharotis imogene* (Parnaby, 2009).

Thomas (1914) proposed the new genus and species *Pharotis imogene* based on a small number of specimens in the Natural History Museum, London, collected by L. Loria from the coastal village of Kamali, Central Province, in November, 1890. These were part of a larger original series in the Museo Civico di Storia Naturale, Genova, Italy consisting of 45 specimens from Kamali, and one specimen from Kapa Kapa, initially identified as *Nyctophilus timoriensis* by Thomas (1897). However, Kamali remained the only authenticated location of *Pharotis imogene* because the identity of the Kapa Kapa specimen was not confirmed as being *Pharotis imogene* by Thomas (1914) and the specimen has not been located in world collections (Flannery, 1995).

There have been no further reports of the New Guinea Big-eared Bat since those originally collected in 1890

and the species was thought to be extinct (Flannery, 1995; Bonaccorso *et al.*, 2008). A specimen from Rogut village, Central Province, Papua New Guinea, thought to be *Pharotis imogene* and reported by Bonaccorso (1998) was examined by one of us (HP) in 1988 and identified as *Nyctophilus microdon*, as noted by Bonaccorso *et al.* (2008). The species is known from very few specimens in world collections and all have originated from Museo Civico di Storia Naturale, Genova, Italy where Loria's specimens were originally housed. Flannery (1995) located six specimens in world collections: three in the Natural History Museum, London, and one each in the Australian Museum, Sydney, the American Museum of Natural History, New York (see Koopman, 1982), and the Zoologisk Museum, Copenhagen. Flannery (1995) reported that all known specimens were adult females, and could all have been obtained from a single roost, which he suspected was a maternity colony.

Broken-Brow and Hughes (2012) captured a bat thought to be either the Small-toothed Nyctophilus *Nyctophilus microdon* or *Pharotis* sp. in the Abau district, 200 km south east of Port Moresby (Fig. 1). Realizing the potential significance of the find, they lodged the specimen in the National Museum & Art Gallery, Port Moresby. In March, 2014, the specimen was loaned to the Australian Museum, Sydney where comparative material enabled confirmation of the specimen as *Pharotis imogene*—the first record of the species since 1890. We discuss the implications of the rediscovery of this species with recommendations for further investigations into its conservation status.



Figure 2. Capture site of *Pharotis imogene* in recently logged rainforest, showing harp trap (photo: Julie Broken-Brow).

Materials and methods

Field work was conducted in the Cloudy Bay Forestry Management Area, a sustainable rainforest logging concession area of some 149,000 ha north-east of Abau, Central Province, Papua New Guinea. Bats were captured in the vicinity of three villages: Bonoabo ($10^{\circ}05'56.1"S$ $148^{\circ}44'53.7"E$) c. 14 km east of Bam ($10^{\circ}06'11.4"S$ $148^{\circ}52'11.7"E$) and Oio Village ($10^{\circ}06'47.5"S$ $148^{\circ}52'22.4"E$), c. 2 km south of Bam. One harp trap and two mist nets were used to capture bats. The harp trap was a standard size, double bank "Austbat" harp

trap (Faunatech, Bairnsdale, Victoria). Mist nets were 38 mm mesh, 12×2.6 m black denier nylon nets (Australian Bird Study Association: Mistnet service, Victoria). Mist nets were arranged one above the other on wooden poles, up to 4 meters above the ground. Mist nets were monitored continuously for 3 to 4 hours after sunset. Captured bats were weighed using a Pesola ® spring balance and measured with digital vernier calipers and released during the night to record echolocation calls. The sex and age of individuals was determined and species identifications were determined in the field using Flannery (1995) and Bonaccorso (1998). Site co-ordinates



Figure 3. The live *Pharotis imogene* captured near Oio Village, taken July 2012 illustrating characteristic large ears and tragus (scale, forearm length = 39.6 mm, photo J. Broken-Brow).

were determined using a 60CSx Garmin ® GPS.

As part of a broader study of the impacts of selective rainforest logging on the mammal fauna of the Cloudy Bay Forestry Management Area, the bat component of field work was undertaken between 14 July and 5 August, and from 4–9 November 2012 (Hughes, 2014; and in prep.). One objective of the bat component of the fieldwork was to capture bats and to assemble a *reference call library* of the recorded calls of local microbat species. Recordings of echolocation calls were taken when bats were released to the wild. However, the main focus of the bat work was an ultrasonic census of the bat community to assess impacts of selective logging, and the preferred foraging habitats of the microbat species. Consequently, net and trap sites were located opportunistically and no attempt was made to systematically sample all habitats in the region.

Mist nets and the harp trap were set along creek lines or logging skid (snig) tracks, which were little wider than the harp trap (Fig. 2). The bat trap was moved after two nights at each site, and the mist nets were moved after one night at each site.

The *Pharotis* voucher specimen was preserved in 90% ethanol, without fixation in formalin and lodged with the National Museum and Art Gallery, Port Moresby, on 4 August 2012 and assigned registration number 27464 in March 2014.

The *Pharotis* specimen reported here was compared with *Nyctophilus* material from New Guinea and a *Pharotis imogene* specimen (M2561) in the Australian Museum mammal collection. Specimens of *Nyctophilus microdon* in the Australian National Wildlife Collection, Canberra

(CM8525) and two specimens of *N. microdon* on loan to the Australian Museum from the American Museum of Natural History, New York (AMNH 12634–35) were also examined because the latter species is poorly represented in the Australian Museum collection.

Results

A total of 42 individuals of 10 species of bats were captured in 11 harp trap nights in July 2012. Few individuals were captured per species, except for the Lesser Blossom Bat *Macroglossus minimus* (Geoffroy, 1810), a pteropod, which accounted for two thirds of all individuals trapped (see Table 1). Mist nets were set for a combined total of 13 nights in July, and nets were also set in November 2012, but, again, few bats were captured. A male *Macroglossus minimus* and a female Common Blossom Bat *Syconycteris australis* (Peters, 1867) were captured in July, but the only captures in November were a substantial number of Diadem Horseshoe-bats *Hipposideros diadema* (Geoffroy, 1813) (number of individuals not recorded).

An adult female *Pharotis* sp. was captured in a harp trap set on a skid track (Fig. 2), by Catherine Hughes and Julie Broken-Brow on 25 July 2012. The capture site (10°07'39.5"S 148°51'41.1"E) was c. 2.0 km SW of Oio Village, in the Cloudy Bay Forestry Management Area (Fig. 1). The site was in recently logged lowland rainforest. The animal was vouchered (PNGM27464, field number B008) and body measurements taken in the field were: forearm length 39.59



Figure 4. *Pharotis imogene* from near Oio Village, live animal showing nose-leaves and skin membrane joining both ears (scale, least distance between nostril margins = 2.5 mm, photo J. Broken-Brown).

mm; head body length 50.12 mm, tibia length 18.93 mm, ear length (measured from anterior base of the tragus) 24.00 mm, calcar 15.04 mm, body weight 7.70 g. The teats were rudimentary, and it was not clear if the animal was nulliparous.

The *Pharotis* specimen from Oio (Figs 3–5) closely resembles M2561 in the Australian Museum collection, (from the original series from Kamali) in overall body size and has a forearm length of 39.6 mm, comparable to 37.5–39.4 mm given for three females by Bonaccorso (1998). It also closely resembles M2561 in the shape and relative size of the anterior nose-leaf, the well-developed posterior nasal prominence, and the relatively large ears and distinctive tragus shape. Both specimens clearly exhibit key diagnostic features proposed

by Thomas (1914) to distinguish *Pharotis* from *Nyctophilus*. These include the convex dorsal margin of the nose-leaf above the nostril (Fig. 6), which contrasts with the median concave margin typical of *Nyctophilus*; a deep pit immediately posterior to the posterior nasal prominence which is absent in *Nyctophilus*, and the lobe on the inner margin of the tragus is located midway between each side of the tragus, rather than located on the outer tragal margin in *Nyctophilus*.

One of the most useful field characters for distinguishing the New Guinea Big-eared Bat from species of *Nyctophilus* is the area of skin between and above the nostrils, which is completely naked (Figs 3–6), but is covered with fine hairs in *Nyctophilus*.

Table 1. Total number of bats captured per species in one harp trap during 11 harp trap-nights during July 2012 in the environs of Bonoabo, Bam and Oio villages, Abau district.

species	females	males
Diadem Horseshoe-bat <i>Hipposideros diadema</i> (Geoffroy, 1813)	1	0
Least Blossom Bat <i>Macroglossus minimus</i> (Geoffroy, 1810)	10	17
Common Bentwing-bat <i>Miniopterus australis</i> Tomes, 1858	2	1
Western Bentwing-bat <i>Miniopterus magnater</i> Sanborn, 1913	1	0
Large-footed Mouse-eared Bat <i>Myotis moluccarum</i> (Thomas, 1915)	2	2
Small-eared Nyctophilus <i>Nyctophilus microtis</i> Thomas, 1888	1	0
New Guinea Big-eared Bat <i>Pharotis imogene</i> Thomas, 1914	1	0
New Guinea Pipistrelle <i>Pipistrellus angulatus angulatus</i> (Peters, 1880)	1	0
Papuan Pipistrelle <i>Pipistrellus papuanus</i> (Peters & Doria, 1880)	1	1
Watts's Pipistrelle <i>Pipistrellus wattsii</i> Kitchener, Caputi & Jones, 1986	1	0
Total captures	21	21



Figure 5. *Pharotis imogene* from near Oio Village, live animal showing erect ears (scale, ear length from base of tragus = 24.0 mm, photo Catherine Hughes).

Discussion

The capture of the New Guinea Big-eared Bat in the Abau district extends the known distribution of the species in the Central Province by some 120 km to the east. It also confirms the prediction by Bonaccorso (1998) that the species remains extant. The current IUCN Red List threat status is *Critically Endangered (possibly extinct)*, under criteria *B1a,b (i, ii, iii)* and *D*, i.e. “likely to have a very small population size, and small range size that is subject to a continued decline in extent of occurrence, area of occupancy, and the extent and quality of habitat” (Bonaccorso *et al.*, 2008). The threat status will now need to be reassessed, but the present record might not necessarily alter the status of Critically Endangered under criterion B of the Red List criteria.

The Oio *Pharotis* was captured as part of an ultrasonic census of the local bat community but there were no call sequences positively identifiable as *Pharotis*, however, the species might have cryptic calls that were not distinguished from *Nyctophilus*. The similarities in external morphology (relatively long-ears) and cranial morphology (large

auditory bulla) between *Pharotis* and *Nyctophilus* have led to speculation that *Pharotis* might also be a low intensity, substrate-gleaning echolocator (Bonaccorso, 1998). Bat species with this foraging strategy are known to have a higher extinction risk (Jones *et al.*, 2003).

Nothing is known about the ecology of the New Guinea Big-eared Bat. Even broad habitat requirements of this species remain unknown but are suspected to be either lowland sclerophyll woodland or woodland with rainforest patches (Bonaccorso *et al.*, 2008). The Oio individual was trapped in rainforest less than 100 m from the boundary between extensive rainforest to the north and a large expanse of grassland (once a coconut plantation) and was within 12 km of the coast and extensive open country. Many bat species are thought to require spatially dispersed roosting and foraging habitats (Law & Dickman, 1998). However, given that the capture of one animal at a rainforest boundary could be fortuitous, detailed surveys are needed to critically determine whether the species requires the proximity of both rainforest and more open habitats. Open sclerophyll savannah or woodland with or without rainforest patches, thought to be



Figure 6. Close up of the snout region of the alcohol-preserved body of *Pharotis imogene* (PNGM27464) showing diagnostic convex dorsal margin of anterior noseleaf (arrow) and naked skin between and above nostrils. Scale: least distance between nostril margins = 2.5 mm (photo Steve Hamilton).

the habitat of this species (Bonaccorso *et al.*, 2008), was notably absent from the capture site of the species south of Oio, suggesting that rainforest might be an important habitat component for the New Guinea Big-eared Bat.

The photograph of the Oio *Pharotis* in Broken-Brow & Hughes (2012) and Figs 3–5 here, are the only published images of a living animal. The only previously published illustrations of the New Guinea Big-eared Bat, to our knowledge, are of the Australian Museum specimen M2561. These include a black and white photograph of the preserved body (Walker, 1964), and line drawings of the head along with skull photographs in Flannery's 1995 publication. Altringham (2011) also has a line drawing of the nose-leaves shown front on. The only other illustration appears to be the drawing of the baculum (penis bone) of an overlooked immature male specimen in the Natural History Museum, London (Hill & Harrison, 1987). The line drawings provided by Flannery (1995) illustrate the anterior nose-leaf which has inevitably been distorted during prolonged storage. Consequently, the anterior nose-leaf has sagged forward, giving the misleading impression that the dorsal margin is concave in the midline, as in *Nyctophilus*, but the margin is convex, which would be apparent if the nose-leaf was fully erect.

In the most recent review of the biology and conservation status of the New Guinea Big-eared Bat, Bonaccorso *et al.* (2008) emphasize that the species is not known from

any protected areas and those authors regard field surveys targeting the species to be one of the highest survey priorities for any bat species in Papua New Guinea. We concur, and accordingly we recommend the following steps to address the conservation status of this species:

- 1 bat surveys using harp traps are urgently undertaken in the Abau district and adjoining lowland regions, to determine the local distribution and abundance in that area;
- 2 priority be given to determining whether the species can be identified from echolocation calls, to facilitate acoustic surveys of the species;
- 3 radio tracking studies be undertaken during different stages of the reproductive cycle to define habitat use, roosting requirements and movements.

A further priority is to establish whether the New Guinea Big-eared Bat is one of a small number of mammal species endemic to the south-eastern peninsula region, or does it occur more widely as suspected by Aplin *et al.* (2010). Surveys should be undertaken in other regions of Papua New Guinea, drawing on insights obtained from steps 1 and 2 above. Such surveys could focus on coastal lowland areas throughout Papua New Guinea, which are amongst the most threatened habitats in the country (Shearman & Bryan, 2011).

Baseline ecological knowledge is lacking for the majority of Papua New Guinea's bat fauna and a third of echolocating species are known from fewer than five localities (Bonaccorso, 1998; Leary & Pennay, 2011). The species taxonomy remains unresolved for much of the bat fauna (Helgen, 2007) and this hinders reliable identification of species. Voucher specimens of bats should be routinely taken during bat surveys to address these deficiencies, as emphasized by Leary & Mamu (2004) and Armstrong & Aplin (2011) and representative specimens should be lodged in the collections of the National Museum, Port Moresby.

ACKNOWLEDGMENTS. The senior author would like to thank the landowners of Bam, Bonoabo, and Oio villages for allowing research on their land. Also, the staff of Cloudy Bay Sustainable Forestry Limited for generous and proactive field assistance: Lindsay Sau (FSC Supervisor), Steven Simaga (Forest Resource Inventory & Planning Supervisor), Raga Golina (Camp Supervisor, ex Resource Forester), and Henry Kawas (GIS Officer). Cloudy Bay Sustainable Forestry Limited, Dr Luke Leung and the first author's father Mr Owen Hughes provided financial support for the study. The first author would also like to thank other family and friends for their support throughout her studies, and Dr Tanya Leary for important guidance. Access to the Australian Museum mammal collection by HP was congenially facilitated by Dr Sandy Ingleby, Collection Manager, who also helped with the *Pharotis* loan. The authors wish to thank Jim Anamiato and Bulisa Iova, Natural History Department, National Museum & Art Gallery, Port Moresby, who arranged for the loan of specimens to the Australian Museum, and two referees Dr Mark Eldridge and Dr Sandy Ingleby (Australian Museum) for constructive suggestions to the manuscript. The manuscript was also enhanced thanks to comments from Dr Ken Aplin, and guidance from the editor, Dr Shane McEvey. HP thanks his father, David Parnaby, for financial assistance during preparation of the manuscript. This study was approved by the PNG government, National Research Institute, with the issue of a three-year Research Visa (reference 1035 0000 8380) to Catherine Hughes.

References

Altringham, J. D. 2011. *Bats: from Evolution to Conservation*. Oxford, United Kingdom: Oxford University Press.

Aplin, K. P., K. M. Helgen, and D. Lunde. 2010. Review of the morphology, distribution and conservation status of *Peroryctes broadbenti* (Ramsay, 1879), the giant bandicoot of south-eastern Papua New Guinea. *American Museum Novitates* 3696: 1–41. <http://dx.doi.org/10.1206/3696.2>

Armstrong, K. N., and K. P. Aplin. 2011. Bats of the Muller Range, Papua New Guinea. In *Rapid Biological Assessments of the Nakanai Mountains and the Upper Strickland Basin: Surveying the Biodiversity of Papua New Guinea's Sublime Karst Environments*, ed. S. J. Richards and B. G. Gamui. RAP Bulletin of Biological Assessment 60: 222–234. Arlington, VA USA: Conservation International.

Bonaccorso, F. J. 1998. *Bats of Papua New Guinea*. Washington DC: Conservation International.

Bonaccorso, F., S. Hamilton, and H. Parnaby. 2008. *Pharotis imogene*. In *IUCN 2013. IUCN Red List of Threatened Species*. Version 2013.2, www.iucnredlist.org (accessed 4 April 2014).

Broken-Brow, J., and C. Hughes. 2012. A batty adventure in Papua New Guinea. *Australasian Bat Society Newsletter* 39: 17–18.

Flannery, T. F. 1995. *Mammals of New Guinea*. Revised edition. Chatswood, NSW Australia: Reed Books.

Helgen, K. M. 2007. A taxonomic and geographic overview of the mammals of Papua. In *The Ecology of Papua*, ed. A. J. Marshall and B. M. Beehler, pp. 689–749. Ecology of Indonesia Series, Vol. VI, Part One. Singapore: Periplus Editions.

Hill, J. E., and D. L. Harrison. 1987. The baculum in the Vespertilioninae (Chiroptera: Vespertilionidae) with a systematic review, a synopsis of *Pipistrellus* and *Eptesicus* and the descriptions of a new genus and subgenus. *Bulletin of the British Museum of Natural History (Zoology)* 52: 225–305.

Hughes, C. 2014. *Effects of Selective Logging on Rattus leucopus and microbats in Lowland Rainforests in Cloudy Bay, Papua New Guinea*. Bachelor of Applied Science, Honours thesis: Animal Studies, University of Queensland, Australia.

Jones, K. E., A. Purvis, and J. L. Gittleman. 2003. Biological correlates of extinction risk in bats. *The American Naturalist* 161: 601–614. <http://dx.doi.org/10.1086/368289>

Koopman, K. F. 1982. Results of the Archbold Expeditions No. 109. Bats from Eastern Papua and the East Papuan Islands. *American Museum Novitates* 2747: 1–34.

Law, B. S., and C. R. Dickman. 1998. The use of habitat mosaics by terrestrial vertebrate fauna: implications for conservation and management. *Biodiversity and Conservation* 7: 323–333. <http://dx.doi.org/10.1023/A:1008877611726>

Leary, T., and T. Mamu. 2004. Conserving Papua New Guinea's forest fauna through community planning. In *The Conservation of Australia's Forest Fauna*, second edition, ed. D. Lunney, pp. 186–207. Mosman, NSW, Australia: Royal Zoological Society of New South Wales. <http://dx.doi.org/10.7882/FS.2004.014>

Leary, T., and M. Pennay. 2011. Echolocation calls of eight microchiroptera from Papua New Guinea. In *The Biology and Conservation of Australasian Bats*, ed. B. Law, P. Eby, D. Lunney and L. Lumsden, pp. 106–127. NSW, Australia: Royal Zoological Society of New South Wales. <http://dx.doi.org/10.7882/FS.2011.014>

Parnaby, H. 2009. A taxonomic review of Australian Greater Long-eared Bats previously known as *Nyctophilus timoriensis* (Chiroptera: Vespertilionidae) and some associated taxa. *Australian Zoologist* 35: 39–81. <http://dx.doi.org/10.7882/AZ.2009.005>

Roehrs, Z. P., J. B. Lack, and R. A. Van Den Bussche. 2010. Tribal phylogenetic relationships within Vespertilioninae (Chiroptera: Vespertilionidae) based on mitochondrial and nuclear sequence data. *Journal of Mammalogy* 91: 1073–1092. <http://dx.doi.org/10.1644/09-MAMM-A-325.1>

Shearman, P., and J. Bryan. 2011. A bioregional analysis of the distribution of rainforest cover, deforestation and degradation in Papua New Guinea. *Austral Ecology* 36: 9–24. <http://dx.doi.org/10.1111/j.1442-9993.2010.02111.x>

Thomas, O. 1897. On the mammals collected in British New Guinea by Dr. Lamberto Loria. *Annali del Museo Civico di Storia Naturale di Genova (series 2)* 18: 606–622.

Thomas, O. 1914. A new genus of bats allied to *Nyctophilus*. *Annals and Magazine of Natural History (series 8)* 14: 381–383.

Walker, E. P. 1964. *Mammals of the World*. Baltimore: Johns Hopkins Press, 3 vols.